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ABSTRACT:

A means (1) for detection of position changes round a joint, especially the spine. The means comprises a vertebral column unit (4) consisting of a number of separate vertebrae (6) and sleeves (12), and a detection unit (5). The vertebral column unit is held together by a tension spring (18) running through all the vertebrae and sleeves. Furthermore, through the vertebrae (6) run at least one flexible draw bar (18) for taking up bending movements and at least one torsion rod (20) for taking up twisting movements. The detection unit (5) is intended for detection of the position changes of the bars and rods. The means is attached close to a patient's back by a fixing unit (14) along the portion of the back to be subjected to measurement and then the different bending and twisting movements may be detected by means of the detection unit. To the detection unit there is connected a registering unit for registration of the values. The means may also be used as a warning means and in that case a warning unit instead of the registering unit is connected to the detection unit.

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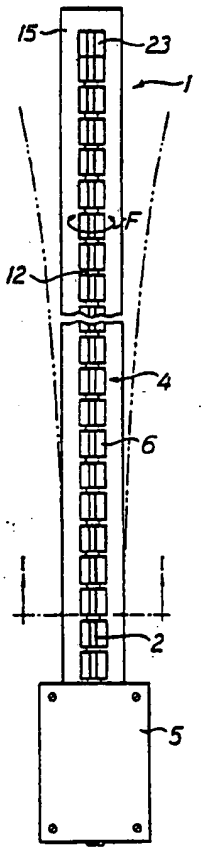
(57) Abstract

A means (1) for detection of position changes round a joint, especially the spine. The means comprises a vertebral column unit (4) consisting of a number of separate vertebrae (6) and sleeves (12), and a detection unit (5). The vertebral column unit is held together by a tension spring (18) running through all the vertebrae and sleeves. Furthermore, through the vertebrae (6) run at least one flexible draw bar (18) for taking up bending movements and at least one torsion rod (20) for taking up twisting movements. The detection unit (5) is intended for detection of the position changes of the bars and rods. The means is attached close to a patient's back by a fixing unit (14) along the portion of the back to be subjected to measurement and then the different bending and twisting movements may be detected by means of the detection unit. To the detection unit there is connected a registering unit for registration of the values. The means may also be used as a warning means and in that case a warning unit instead of the registering unit is connected to the detection unit.



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MEANS FOR DETECTION OF SPINAL MOVEMENTS

FIELD OF THE INVENTION

The present invention relates to a means for registration of the bending and twisting movements of the spine

PRIOR ART

Backache is a big global problem. Today it is estimated that three fourths of all people once during their lifetime will get so severe back problems that they will be unable to work

Backache is one of the most frequent reasons for sick-leave, and in Sweden alone the costs of medical care and fall in production related to this is estimated to between four and five milliard per year

Many attempts have been made to diagnose backpain in a technical way and guided by the diagnosis to treat a patient properly.

However, hitherto no thorough solution to the problem has been found which at the same time is practical and simple

WO 83/03747 shows a back warning means, based on a metal ball rolling into contact with a plate metal by twisting and bending, and thus closing a circuit. The means is attached to the patient's back and warns the patient when he or she is close to a harmful movement However, this means only gives an indication, i.e. when there is contact. No individual grading is possible since this requires a zero adjustment for each individual and there is not obtained any division of the movements into bending and twisting moments

US patent 3 608 541 shows a means for detection of spinal bendings consisting of an articulated column which is attached over the spine by means of a corset A thread running through the articulated elements is stretched at bending and then gives a signal. The means gives only one possible adjustment, by the thread, and the indication received gives no picture of the movement. Besides, the means is cumbersome to wear

EP 0 041 807 shows a means and a method for establishing the movability at a joint. The means is based on the conductivity of a material being changed by stretching and on the changes of conductivity being registered.

Moreover, e g. a back bench has been designed for diagnosing and treating back injuries. The bench may be prolonged, rotated and turned. However, this bench is expensive as well as technically and spaciously demanding

The big disadvantage of the means according to prior art is that a division of a combined movement into bending and twisting movements in different directions cannot be obtained. A detailed picture of the patient's trouble is of utmost importance in order to give an effective and correct treatment.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a means for registration of movements especially round the spine. The means can be designed both as a measuring device, by which a doctor may diagnose the injury, and as a "warning device", intended to be used daily by the patient himself in order to avoid harmful movements.

Another object of the present invention is to provide a means by which both rotating and bending movements in different directions may be separately detected.

Yet another object of the present invention is to provide a means that has low production costs and is simple, handy and practical in use.

These objects are achieved by a means for detection of position changes round a joint, especially the spine. The means according to the invention comprises a vertebral column device consisting of a number of separate vertebrae The vertebrae are held together by means of a through, flexible tension spring, and between the vertebrae are spherical sleeves pivoted in the vertebrae. Moreover, at least one draw bar runs through the vertebrae for taking up bending movements, preferably three, and at least one rod for taking up twisting movements, preferably one. Besides, the means comprises a unit for detecting the

position changes of the draw bars or the rods and a fixing unit for attaching the means to the spine. The detection unit comprises a transducer for each draw bar and rod, respectively, for detecting the position changes of it.

The idea of the means according to the invention is based on it trying to imitate the spine to the greatest possible extent. The means, intended to be attached to the spine by a fixing unit, takes up both bending and twisting movements round the spine by virtue of the included bars and rods and these bending and twisting movements are detected by a transducer for each bar/rod. Every small movement round the spine may be transferred to the means due to the uniting, flexible tension spring and the guiding sleeves. Thus, with a number of bars and rods a separate division of different bending and twisting movements, respectively, may be achieved, and it may be exactly determined what kind of movement or movements e.g. causes pain to the patient and, thus, should be avoided. A suitable instrument is connected to the transducers of the means for registration of the different movements. It is also possible to design the means as a warning instrument in which some kind of a warning unit is connected to the transducers e.g. in order to give a signal or an electric impulse to the patient when certain values of the movements have been achieved.

The means according to the present invention is especially intended for detection of movements round the spine, and therefore, the detailed specification below relates to such a means even though it is possible to detect movements round other joints.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front view of the means according to the invention seen from the side turned away from the spine;

Fig. 2 is a sectional view along the line I-I in Fig. 1 showing a separate part of the vertebra sectionated;

Fig. 3 is a view of a separate vertebra viewed along the line II-II in Fig. 2;

Fig. 4 is a view of the detection part of the means seen

from behind and partly in section;

Fig. 5 is a view of a band with fastening pins intended to be attached to the patient's spine and is taken from the side facing the spine;

Fig. 6 is a side view of the means according to the invention; and

Fig. 7 is a view of a separate sleeve placed between the vertebrae.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to Fig. 1 there is shown a means 1 comprising a vertebral column unit 4 and a detection unit 5. To define the means 1 in space we call the side visible in Fig. 1 front side 2 and the opposite side reverse side 3, which side is shown in Fig. 6. The vertebral column unit 4 is made of a number of specific, separate vertebrae 6. Such a specific vertebra is shown sectionated in both Fig. 2 and Fig. 3, and will be further explained below.

Between the separate vertebrae 6 are centrally placed sleeves 12, movably lodged in counterbores 11 in each end of the vertebrae 6. Preferably, these sleeves have a spherical shape in order to work correctly as a joint between the vertebrae 6. One embodiment of a sleeve is shown in Fig. 7, and can be closest described as a ball sleeve. An aperture 17 passes through the sleeve. A closely spun tension spring 19 made of rolled spring wire runs centrally through the vertebrae 6 and the sleeves 12 and holds together the entire vertebral column unit with light spring force, and by virtue of its flexibility it causes the vertebral column unit to closely follow the movements of the spine. The outer diameter of the tension spring is principally the same as the inner diameter of the holes 17 in the sleeves 12, implying that the sleeves are fixed round the tension spring.

A torsionally rigid torsion rod 20 runs with clearance inside the tension spring 19, and symmetrically round the tension spring run draw bars 18. Thus, the draw bars 18 run outside and parallel with the sleeves 12 but through the

vertebrae 6, and are intended for taking up bending movements round the spine. The centrally placed torsion rod 20 is intended for taking up twisting movements round the spine.

Each single vertebra 6, one of which is shown in Figs. 2 and 3, respectively, has through holes 7 and 10 for the draw bars 18, the tension spring 19, and the torsion rod 20, respectively. Referring to the vertebra 6 of Fig 2 it is clear that the upper part of it, earlier defined as the front side 2, in the shown embodiment has bevelled edges. Other forms are of course possible since the form is not crucial. On the reverse side 3 of the means the vertebra 6 has a recess 13, intended for receiving a fastening pin 16, fixed to a band 15, which will be described later. The recess 13 and the pin 16 have preferably complimentary forms, but, of course, the exact design can vary. There has to be a certain clearance between the fastening pin 16 and the recess 13 so as to enable the vertebral column unit to run along the band 15 when the means is taken away from or applied to the patient, and as the skin and the band extend in bending.

At the mouth of the through hole 10 on each side of the vertebra 6 is a counterbore or a guiding seat 11, in which the intermediate, spherical sleeves 12 are lodged. As mentioned earlier, both the uniting tension spring 19 and the torsion rod 20, which runs within the tension spring 19, run through these holes 10. The holes 10 in the vertebrae 6 have a diameter larger than the diameter of the tension spring, and thus, clearance is provided for the spring. On the other hand, the diameters of the tension spring 19 and the holes 17 of the sleeves are essentially the same so that the sleeves are fixed on the tension spring.

The through holes 7 for the draw bars 18 have a thin guiding part 8 in the centre of the vertebra 6 and thicker clearance parts 9 round this guiding part 8. This is shown in Fig. 3. The diameters of the holes in the guiding parts are essentially the same as the diameters of the draw bars 18, which means that the draw bars 18 are guided by these thin guiding parts. The diameters of the thicker parts 9 are larger than the

diameters of the draw bars 18, which allows of the clearance of the bars at bending.

The tension spring 19 is anchored in the detection unit 5 and in the uppermost vertebra, especially designated with the reference numeral 23. It can also be made as a larger, fixed unit. The tension spring 19 is lightly stretched at the attachment in order to hold together the vertebral column with a certain spring force. The vertebral column unit 4 is connected at its lower end to the detection unit 5 by a last spherical sleeve 12 and the tension spring 19.

Referring to Fig. 4 it appears that both the draw bars 13 and the tension rod 20 are connected to a transducer, the potentiometers 21 and 22, respectively, in the detection unit 5. Furthermore, the draw bars 18 and the tension rod 20 are anchored in the uppermost vertebra 23, preferably by clamping screws allowing a length correction at calibration. Furthermore, the upper, fixed vertebra 23 is conveniently designed open at the top so as to obtain free access to the draw bars and the torsion rod for fine adjustment or possibly replacement.

At bending and twisting of the means the potentiometers are affected and this change may then be transferred to a suitable registering instrument.

Fig. 5 shows a fixation unit 14 comprising an elastic band 15 and fastening pins 16 arranged thereon. Conveniently the elastic band 15 is provided with an adhesiv on the reverse side, i.e. the side to be attached to the patient's back, and e.g. a covering paper, which can be torn away. The band 15 easily sticks to the patient's back and then the means 1 is threaded over the fastening pins 16 via the recesses of the vertebrae 6. The band 15 runs all along the vertebral column unit 4, while, conveniently, the detection unit 5 is attached to the patient's back with Velcro® fastening. The elastic band has fastening pins 16 and there should be at least as many fastening pins as separate vertebrae 6, each fastening pin engaging each separate vertebra in accordance with Fig. 2. It is essential that all of the means closely abuts the patient's back in order to obtain correct values.

Fig. 6 is a side view of the means according to the invention, and with dashed lines it is chiefly shown how the means may be bent forwards and backwards. Returning to Fig. 1, also this figure shows the flexibility sideways of the means, and the swivelling feature is indicated with the arrow F.

To the detection unit 5 with the different transducers 21 and 22, respectively, a registering instrument (not shown) as well as some kind of warning unit (not shown) may be connected. The registering unit is used by the doctor in order for him to establish a clear picture of the patient's trouble, while the warning unit is used when the patient is wearing the means, in order to warn the patient by e.g. a sound signal or vibration signal or to draw his or her attention to the fact that a certain movement is incorrect or even harmful.

The separate vertebrae should be made of a durable and above all a light material, a preferred material being plastic.

The means may comprise a varying number of draw bars and torsion rods, however, at least one of each, but according to a preferred embodiment it comprises three draw bars and one torsion rod.

The means according to the present invention works in the following way.

The means 1 is attached to a patient so that it covers the portion of the back to be subjected to the measurment, e.g. the loin. First the adhesiv, elastic band 15 is applied and then, as stated above, the vertebral column unit 4 with the detection unit 5 is threaded over the fastening pins 16. Conveniently, the detection unit 5 is attached to the patient's back with a Velcro® fastening. Due to the attachment of the vertebral column unit over the fastening pins 16 on the band 15 the vertebral column unit can easily be drawn from and displaced along the band when necessary and can easily slide along the band with unchanged abutment as the skin is prolonged at bending.

The draw bars and the torsion rod are calibrated after each individual patient. Then when the patient bends or twists or makes a combined movement the vertebral column unit follows the

movements of the spine and via the included draw bars 18 and torsion rod these movements are transferred to the transducers of the detection unit. A twisting movement affects the potentiometer 22 while different bending movements affect the potentiometers 21. In most cases a movement is a combination of bending and twisting and the great advantage of the present means is then that this combination of movements may be divided into a number of values, showing bending forwards and backwards, bending sideways to the right and to the left, and twisting to the right and to the left, respectively.

By connecting a registering unit the values of perfect bendings sideways, bendings forwards and backwards, and twisting to the right and to the left may be zeroed to obtain the proper starting point for each patient irrespectively of the shape of the back.

These values can then be used by a doctor to construct a table or a schedule showing what movements the particular patient should avoid.

The means may also be used as a warning instrument and instead of connecting it to a registering unit of the detection unit it may be connected to some kind of warning unit, e.g. a unit having a tone generator or a unit having an oscillator. In all other respects the means is constructed in exactly the same way when used as a warning device and as a measuring instrument, but instead of measuring different movements the warning device is designed to warn the patient when certain preselected values are reached. Conveniently, the adjustment is made such that the patient is warned before a harmful position is reached.

Due to the means according to the present invention different perfect bending and twisting movements and combined bending and twisting movements can be measured and registered. The maximal movements in different directions for a patient with a back injury are recorded as a base for both treatment and adjustment of the back warning instrument working in the same way. The patient may now compare during e.g. a period of treatment his values with previously measured values and note improvements or worsenings. A very important part is that by

using the back warning instrument the patient can avoid harmful movements and hence shorten the time of healing. There is reason to believe that the preventive rhytm of movement learnt at an occasion of illness will remain and in that way reduce the risk of a relapse. Being able to follow exactly the development of each patient is a great advantage for the doctor.

According to the embodiment shown in the drawings the back measuring and warning means is intended for applying over the vertebrae of the spine at the loin, however, the instrument may of course be designed, according to the same principle, to fit also over the remaining portions of the spine.

Even though the instrument so far has been described only as applicable for the spine it may of course also be designed to fit e.g. the cervical vertebrae and other human joints, knee joints, ankle joints etc. Knee injuries as well as back injuraies are frequent and they are a major problem.

The means according to the present invention may be modified in various ways by a person skilled in the art and is only limited by the following claims.

CLAIMS

1. A means for detection of position changes round a joint, especially the spine, c h a r a c t e r i z e d in that it comprises

a vertebral column unit (4) consisting of a number of separate vertebrae (6) and sleeves (12) held together by a tension spring (19);

at least one flexible draw bar (18) running through the vertebrae for taking up bending movements and at least one rod (20) running through the vertebrae for taking up twisting movements; and

a unit (5) for detection of the position changes of the bar/bars and the rod/rods.

2. A means according to claim 1, c h a r a c t e r i z e d in that it comprises three draw bars (18) for taking up bending movements and one torsion rod (20) for taking up twisting movements.

3. A means according to claim 1 or 2, c h a r a c t e r i z e d in that the unit (5) for detection of position changes of the draw bar/bars and the rod/rods (18, 20) respectively, comprises a transducer (21, 22) for each bar/rod.

4. A means according to any of claims 1 - 3, c h a r a c t e r i z e d in that the rod (20) is a torsional rigid torsion rod and in that the tension spring (19) is arranged round the torsion rod and is a closely spun tension spring made of rolled spring wire.

5. A means according to claims 1 - 4, c h a r a c t e r i z e d in that the sleeves (12) are spherical, preferably ball sleeves.

6. A means according to any of the previous claims, c h a r a c t e r i z e d in that the rod (20) runs through the vertebrae (6) and the sleeves (12), while the draw bars (18) run through the vertebrae but outside and parallel with the sleeves.

7. A means according to any of the previous claims, c h a r a c t e r i z e d in that it further comprises a fixing unit (14), by the virtue of which the vertebral column unit (4)

may be attached closely adjacent to the spine.

8. A means according to claim 7, c h a r a c t e r i z e d in that the fixing unit (14) comprises an elastic band (15) and fastening pins (16).

9. A means according to claim 8, c h a r a c t e r i z e d in that the elastic band (15) is furnished with an adhesive on the side intended for attachment to the spine.

10. A means according to any of the previous claims, c h a r a c t e r i z e d in that the vertebrae (6) are made of a plastic material.

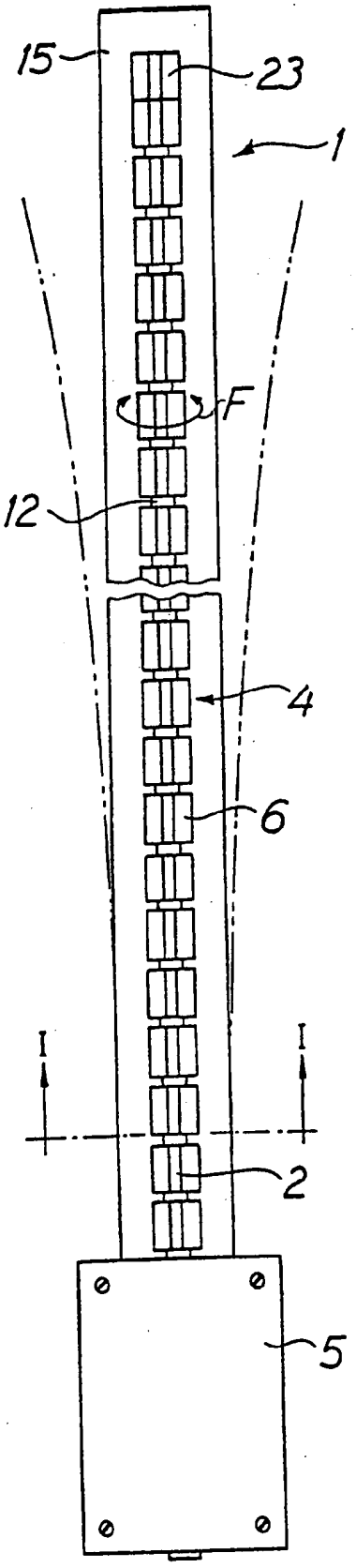

FIG. 1

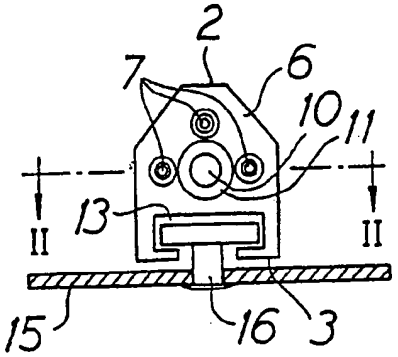

FIG. 2

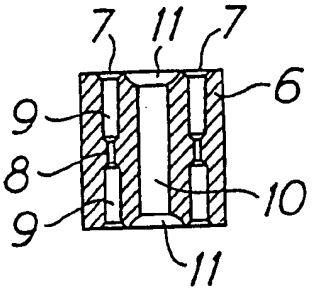

FIG. 3

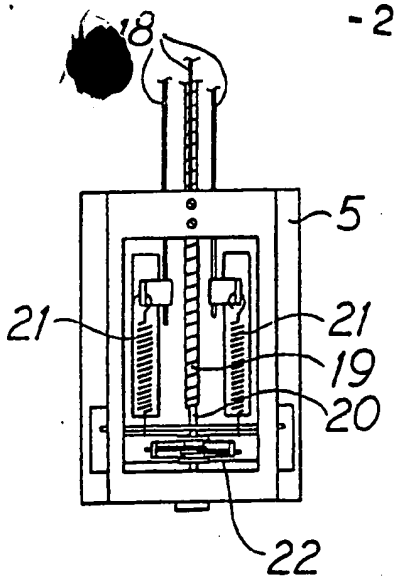

FIG. 4

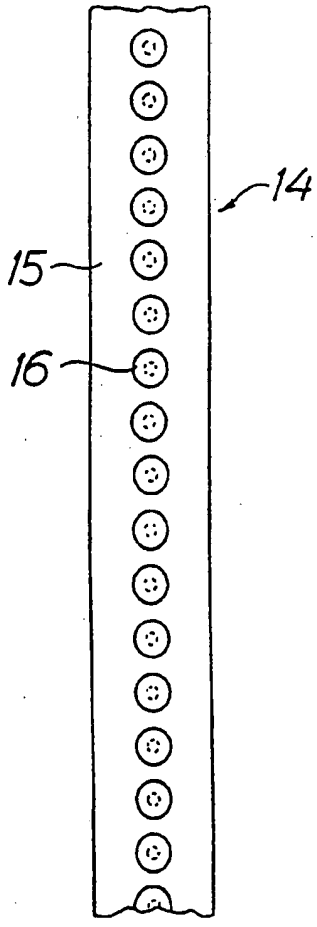

FIG. 5

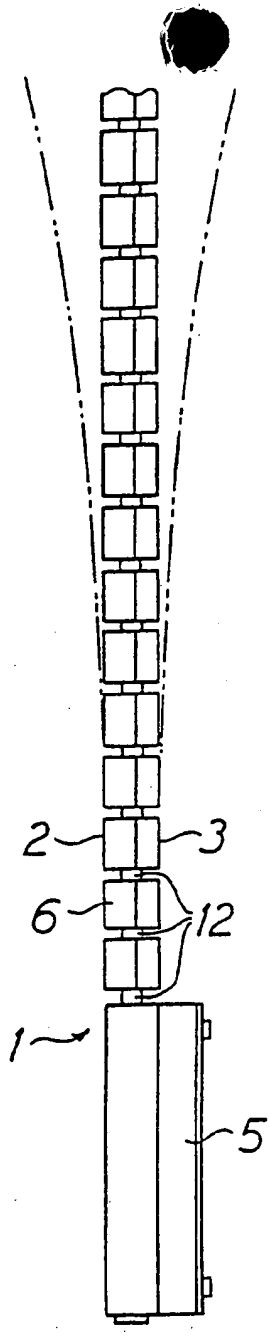

FIG. 6

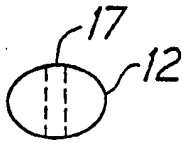

FIG. 7

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE88/00275

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC4

A 61 B 5/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	A 61 B 5/10
US Cl	128:25, 774, 781, 782; 340:279

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X,E	SE, B, 455 567 (BERTIL JOSEFSSON) 25 July 1988 See the whole document.	1-10
A	US, A, 3 991 745(YOSLOW ET AL) 16 November 1976 See e.g. claims.	1
A	US, A, 3 608 541 (LELAND V.HALL) 28 September 1971	
A	CH, A5, 659 938 (SAVERIN KEMPINSKI) 13 March 1987	

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IV. CERTIFICATION

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1988-12-22	1988 -12- 23
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